April 1974 B74-10024

NASA TECH BRIEF

Goddard Space Flight Center

Traffic Control System and Method

The problem:

Supersonic transports (SST's), in addition to their objectionable sonic boom, impose a communication problem. Because of their speed of approximately 2000 knots, they require constant monitoring by the ground control stations to prevent possible collisions with other aircraft. Supersonic speeds, however, introduce large Doppler shifts in the communication frequencies. At 2000 knots, a two-way Doppler shift is about ±10 kHz on a 1.5-GHz carrier. This shift requires some means of compensation. One method of overcoming this problem is to allocate a sufficiently broad bandwidth for each SST to include the maximum Doppler shift. However, the bandwidth associated with each SST would then be too great for efficient communication. Another approach involves the exact compensation for the Doppler shift, whereby each SST would be equipped with an ultrastable oscillator to maintain a constant transmitted frequency regardless of the shift. This approach is impractical because oscillators with the required stability cannot be flown on each aircraft.

The solution:

An air traffic control system and method were developed which use a compromise between exact Doppler frequency compensation and a system requiring a large bandwidth.

How it's done:

The frequency of the carrier received by an aircraft is measured and compared with a reference to indicate the magnitude of the Doppler shift. In response to the difference between the received and reference frequencies, one of the Doppler frequency ranges is selected and indicated by a digital signal. This signal modulates the carrier transmitted from the aircraft. The difference between the boundary value of the selected range and the difference frequency is an offset of the apparent carrier frequency, or frequency without Doppler shift, transmitted by aircraft. The ground station responds to the digital signal from the aircraft and feeds it to a computer for aircraft position indication, simultaneously monitoring the actual carrier. Phase coherence between the aircraft and ground station is thus preserved without the requirement for a wide bandwidth.

To prevent the carrier frequency from oscillating between two boundary values as the Doppler frequency shifts slightly about the boundary, hysteresis is provided in the aircraft Doppler compensation circuit, indicating the frequency range. Hysteresis delays the shifting from first frequency range to the second adjacent, overlapping range, as long as the shifting persists.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Code 207.1
Greenbelt, Maryland 20771
Reference: B74-10024

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,715,663). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
Goddard Space Flight Center
Code 204
Greenbelt, Maryland 20771

Source: Charles R. Laughlin,
Roger C. Hollenbaugh, and
Walter K. Allen
Goddard Space Flight Center
(GSC-10087)

Category 02